

Mara River Flows

Integrated Water Resource Management

... for people and for nature

September 2009

Greetings from the Mara River Basin, and thanks to all the folks who recently have been expressing interest in our research on the river and this newsletter. This is certainly an exciting time to be working on the Mara River. Although the Serengeti-Mara Ecosystem is one of the most famous conservation areas in the world, there has been a surprising paucity of research conducted on the river itself. Of course, there are a number of notable exceptions, but for the most part, people are hungry for information – actual data – about the current status of the river. We feel very fortunate to be able to present some of that here.

State of the River



Old Mara Bridge – August 7th, 2009



Old Mara Bridge – September 27th, 2009



Old Mara Bridge – September 10th, 2008

Although a large portion of the basin continues to suffer the effects of a 3 year drought, we were relieved to see the short rains begin in late August. With regular rainfall in the upper catchment and in the northwestern portion of the Masai Mara National Reserve (historically the wettest area of the Reserve), the river has risen quite a bit this month, as you can see in the photos above. These pictures were taken from the Old Mara Bridge (OMB), just north of the Reserve. As you can see, water levels are up from last month, but they still are not as high as they were last year during this time, as shown here to the left. You can also the

impacts of the rising water levels on water quality in the table below.

Water quality parameters in the for the Mara River – 2008 and 2009 snapshots

Date M/D/Y	Time hh:mm:ss	Site	Temp C	DO %	pH	Conductivity mS/cm	Salinity ppt	TDS g/L
9/10/2008	16:34:00	Old Mara Bridge	21.2	84.4	6.44	0.076	0.03	0.05
8/7/2009	17:34:54	Old Mara Bridge	25.55	84.2	8.59	0.330	0.15	0.212
9/27/2009	11:12:28	Old Mara Bridge	23.47	78.5	7.68	0.130	0.06	0.084

We have been focusing a lot on dissolved oxygen (DO) recently, because nearly all stream organisms are sensitive to oxygen concentration; thus, it seems appropriate to discuss it in greater detail here. Dissolved oxygen levels can be affected by several variables¹:

1. DO increases as temperature decreases.
2. DO decreases with decreasing atmospheric pressure associated with different elevations or barometric change of weather
3. DO decreases with increasing levels of nutrients via organic waste, as microbial processes consume the oxygen from the water.
4. DO may increase throughout the day, as photosynthesis by plants and algae releases oxygen, and decrease at night, as respiration reduces oxygen concentration.

These multiple variables can make it challenging to interpret the meaning of changing DO levels. For example, it may seem surprising at first that DO levels at the OMB actually dropped between August and September, although water levels were rising. However, one needs to note the time of day at which the samples were taken, as the lower levels were from samples taken earlier in the day. During October, we plan to conduct 24-hour sampling of the Mara River, during which we will document DO levels each hour, in order to gain a better understanding of the daily fluctuations in these parameters.

In most unpolluted streams and rivers, DO concentrations remain well above 80%, and levels below 30% are considered hypoxic and generally fatal for many fish species. Interestingly, on 8/7/2009 at our sample site at the New Mara Bridge, which is located on the border between the Masai Mara and the Serengeti, the DO was 30%. On the same day, at the Old Mara Bridge upstream of the protected areas, the DO was 84.2%. During the September sampling, DO levels at the New Mara Bridge had risen to 59.5%, although they remained fairly consistent at 78.5% at the OMB. As we described in the last newsletter, very low DO levels can be caused by very high nutrient concentrations in the water. This difference between DO levels at sites upstream and within the Reserve suggests that nutrient inputs may be higher inside the protected areas. Potential sources could be sewage effluent from tourism facilities, fecal deposition from hippos or effects of the wildebeest migration. However, the continued lack of significant wildebeest mortality events makes the latter source unlikely. This is a subject of great interest to us, and one we hope to be able to shed more light on in the future.

¹ Hauer, F.R. and W.R. Hill.1996. Temperature, light, and oxygen. *In* Methods in Stream Ecology. F.R. Hauer and G.A. Lamberti, Eds. Academic Press, San Diego, California, USA.

Research

With the completion of our intensive macroinvertebrate sampling in August, this month we had a bit more time to explore the river, look for future study sites and make some natural history observations. Here are two of the most striking...

For those of you not so familiar with the Mara, the wildebeest don't actually cross in one single, amazing spectacle. They actually ramble back and forth around the Reserve, occasionally coming upon the river and, in what seems like an almost random act of courage and bravado, one individual will get the courage up to dive in and swim across, followed with dedication by the rest of the herd. And they seem to do this fairly frequently at several well-defined "crossing points." These points are marked on a map, and tourist vans jockey for good positions where their clients can sit and sip wine as they wait for this event to occur. Normally, a number of these crossings will result in the death of hundreds to thousands of wildebeest, either from crossing at too steep of a location, drownings or crocodile attacks.

Well, regardless of the number of sporadic crossings that have occurred this year, we haven't seen the masses of bodies that we saw last year. This is likely due to the lower-than-usual water levels that have made it fairly easy for them to cross, and fairly difficult for the crocodiles to attack. We have been wondering about the effects of this low wildebeest mortality on the crocodiles of the Mara River, being a bit partial to these prehistoric beasts as we are. Indeed, during our travels this past week, we only saw two occurrences of crocodiles feeding on very small numbers of wildebeest carcasses, nothing like the average numbers of dead wildebeest that typically clog the river during this time of year. For example, during the last crossing of last year, the Mara Conservancy website estimated that 3-4,000



Picture 1: Four crocodiles basking in the sun the day after feasting on a hippo carcass

wildebeest perished. But in one location of the river, we came upon 29 adult crocodiles within a 300 m stretch, some of them remarkably large. Crocodiles are typically somewhat territorial, but the stench of something dead indicated they were hanging around together for a reason. Scouting the river banks, we

spotted a dead hippo in the midst of the crocodiles. 29 crocodiles and 1 dead hippo! This is not the feast these guys are accustomed to at this time of year. It also makes us wonder if lower than normal water levels have led to increased aggression between hippos and crocs.

Which brings us to another interesting indication of the times...

While observing the river during a predicted rain storm that never materialized, we did see several large crocodiles feeding on a single wildebeest carcass. However, to our surprise, several hippos from a group downstream moved in and "pushed" the crocodiles away from the carcass. We then observed these same hippos begin eating the wildebeest carcass. We watched this for close to 80 minutes and documented it with many photographs.

The potential for typically vegetarian hippos to turn carnivorous was first scientifically documented about ten years ago by Joseph P. Dudley². Here is a short quote from a 1999 article in *Natural History*:

Field biologist Joseph P. Dudley, formerly at Hwange National Park in Zimbabwe, observed a male hippo killing an impala ram that had swum through a pond to evade a wild dog. After eating some of the meat, the hippo returned to his herd. A few minutes later, ten more individuals from the group gathered at the floating carcass for a communal feast. Later a few of them climbed the pond's banks to wrest another dead impala from wild dogs. "It seems almost incredible," writes Dudley, "that carnivorous feeding behavior by hippos, even if of very infrequent occurrence, could have gone unreported for so long." Perhaps, he opines, the behavior may have been attributable to "nutritional stress caused by severe drought conditions."

This last remark by Dudley is particularly noteworthy. These "severe drought conditions" may be the same conditions we are currently experiencing in the Masai Mara National Reserve. We have asked several rangers and guides if they ever witnessed anything similar and they stated that, although they have seen hippos playing with wildebeest carcasses and perhaps nudging them or biting into them, they have never actually seen them consuming the meat. It was very clear in the photos that we have



Picture 2: Hippos and crocodiles feeding on a wildebeest carcass

taken that the hippos involved were consuming the meat from the wildebeest carcass. Here is a photo of two hippos chewing on the head of the carcass while one of the large crocodiles was chewing on the foot. Not only does this possibly indicate nutritional stress within the Masai Mara, but this also raises the interesting specter of transfer of wildlife diseases to hippos through previously unknown pathways. In fact, the feeding of hippos on carcasses and the subsequent spread of anthrax was hypothesized to be the impetus for a large hippo die-off in Uganda in 2004.³

In other interesting research updates, we are excited to be working with Governor's Camp to begin some really interesting sampling this month. As we mentioned in a previous newsletter, Governor's Camp has been collecting daily rainfall data since 1999, providing one of the few complete and up-to-date rainfall records for the region. Not only have they agreed to share this data with us, but now, Patrick Beresford, in cooperation with the management of the camp, has agreed to assist us further by collecting monthly water samples of rainfall and groundwater, in addition to measuring groundwater depth. Using isotopic analysis, we plan to use the rainfall and groundwater data to determine the

² Dudley, J.P., 1996. Record of carnivory, scavenging and predation for Hippopotamus amphibius in Hwange National Park, Zimbabwe 1996. *Mammalia-Paris*, 60 (3), pp.486-487.

³ Bhattacharya, S. 2004. Cannibalism may have spread anthrax in hippos. (New Scientist) [Online] (Updated 20 Dec 2004) <http://www.newscientist.com/article/dn6818-cannibalism-may-have-spread-anthrax-in-hippos.html> [Accessed 03 Oct 2009].

“signature” for both surface and groundwater in the area. Then, by analyzing samples of river water, we hope to determine what portion of the river is comprised of groundwater. I know this may seem a bit academic at first glance, but consider this... as river levels fall, people and industries increasingly drill wells and boreholes to tap groundwater for their abstraction needs, thinking this does not affect the river. But groundwater inevitably infiltrates into the river, probably playing a vital role in sustaining dry season flows. Anecdotal reports exist of falling groundwater levels, but there is little to no monitoring of this critical resource. By continuing to drain the groundwater, ultimately the surface waters will suffer as well. Not only is this a great way for us to get some interesting and important data, but it is also an example of how private businesses can foster sustainability through contributions to research. In turn, we hope to repay them by assisting with their on-site water quality monitoring.

Governance

As exciting as research is, the real heart of the matter is implementing the findings and recommendations of the research. That is why we are so excited about a new partnership between USAID/East Africa and the East African Community. For the first stage of the partnership, USAID/EA has decided to give a three year, \$3 million USD grant to the Lake Victoria Basin Commission (the sector of the EAC responsible for the sustainable development of the Lake Victoria Basin) to improve regional cooperation and management of the Mara River Basin. The aim is for these funds to support the implementation of the research and reports that WWF, FIU and other partners in the basin have been working on for the past few years, including a Biodiversity Action Plan, Environmental Flow Assessment and Strategic Environmental Assessment for the Mara River Basin. This is an exciting opportunity to see research findings implemented, and we look forward to keeping you posted as the program develops.

September also marked the first meeting of the Kenya National Stakeholder Forum for the Mara River Basin. This is a national group of governmental and non-governmental groups with a stake in the sustainable development of the MRB. Formation of this group establishes a working group for development of management plans in the basin, as well as an important platform for dialogue.

In early October, we look forward to another development in the governance of the MRB. WWF will be hosting a workshop on implementation of a Payment for Ecosystem Services (PES) scheme in the MRB. PES determines providers and buyers of ecosystem services, which in the case of a river basin is typically upstream and downstream residents, respectively. The PES approach is based on the understanding that, 1) ecosystems provide valuable services (clean water, biodiversity, etc.) for which people should be willing to pay, and 2) downstream residents benefit from the ecosystem services of the river sustained by good land and water resource management practices of upstream residents. Downstream residents can help sustain these ecosystem services upon which they depend by paying upstream residents to implement best management practices, which they otherwise may not be able to afford to do. Check out our blog for a recent MSc thesis by George Atisa, of FIU, to learn more about this innovative approach to conservation (maraadventure.blogspot.com).

Other Interesting Happenings

We were honored this month to be part of a documentary on the Mara being conducted by Alison Jones and the documentary team at No Water No Life (www.nowater-nolife.org). Alison is doing a

comparative study of 6 river basins – 3 in Africa and 3 in North America – to raise awareness about the increasingly critical state of water resources and what can be done to conserve them. She also has a personal affinity to the Mara, as one of the founding members of the Mara Conservancy. We spent a day being interviewed and photographed by Alison Jones and the videographer Alison Fast, and also going to the river together to conduct some sampling. This was our first experience being interviewed in front of a camera on behalf of the river, and we hope we did justice to both the challenges and advances of conservation in the basin.

This month also saw the submission of the Tanzania iWASH program proposal that Chris has been helping to prepare. This program will utilize a very innovative and integrated approach to water resource management and service provision, which draws on the expertise of some of the most experienced partners in the region. So far, we have received supportive and excited feedback from USAID/Tanzania, and we look forward to receiving formal acceptance so we can see it on the ground.

And finally... a thank you to some good Samaritans in the Masai Mara. While traveling from the New Mara Bridge to the Mara Conservancy, our rear propeller and hand brake drum fell from the vehicle. To make matters worse, we could not engage diff lock so we were stuck in the middle of the road. Luckily, this is still the high season and many tourists passed us...some actually stopping. One group of visitors from Virginia actually had a mechanic in their vehicle, and they were kind enough to interrupt their game drive so he could assist us. He climbed under the car to help completely disconnect the rear propeller so that we could be towed. Fortunately, we were soon discovered by the Mara Conservancy Rangers, who brought a mechanic to assist and then towed us back to the garage. Once there, it was an easy fix with the skilled folks at the Conservancy garage. So thank you to both the Mara Conservancy and our friendly group of tourists. Virginia really is for lovers!



Picture 3: Amanda pulling our vehicle through the Masai Mara



Picture 4: Good Samaritans from Virginia

See you next month!

October is going to be a busy month for us, with several important workshops, some new grad students coming in and new sampling events we have planned for the Mara. We also expect to see the rains continue and even increase. We look forward to telling you all about it!